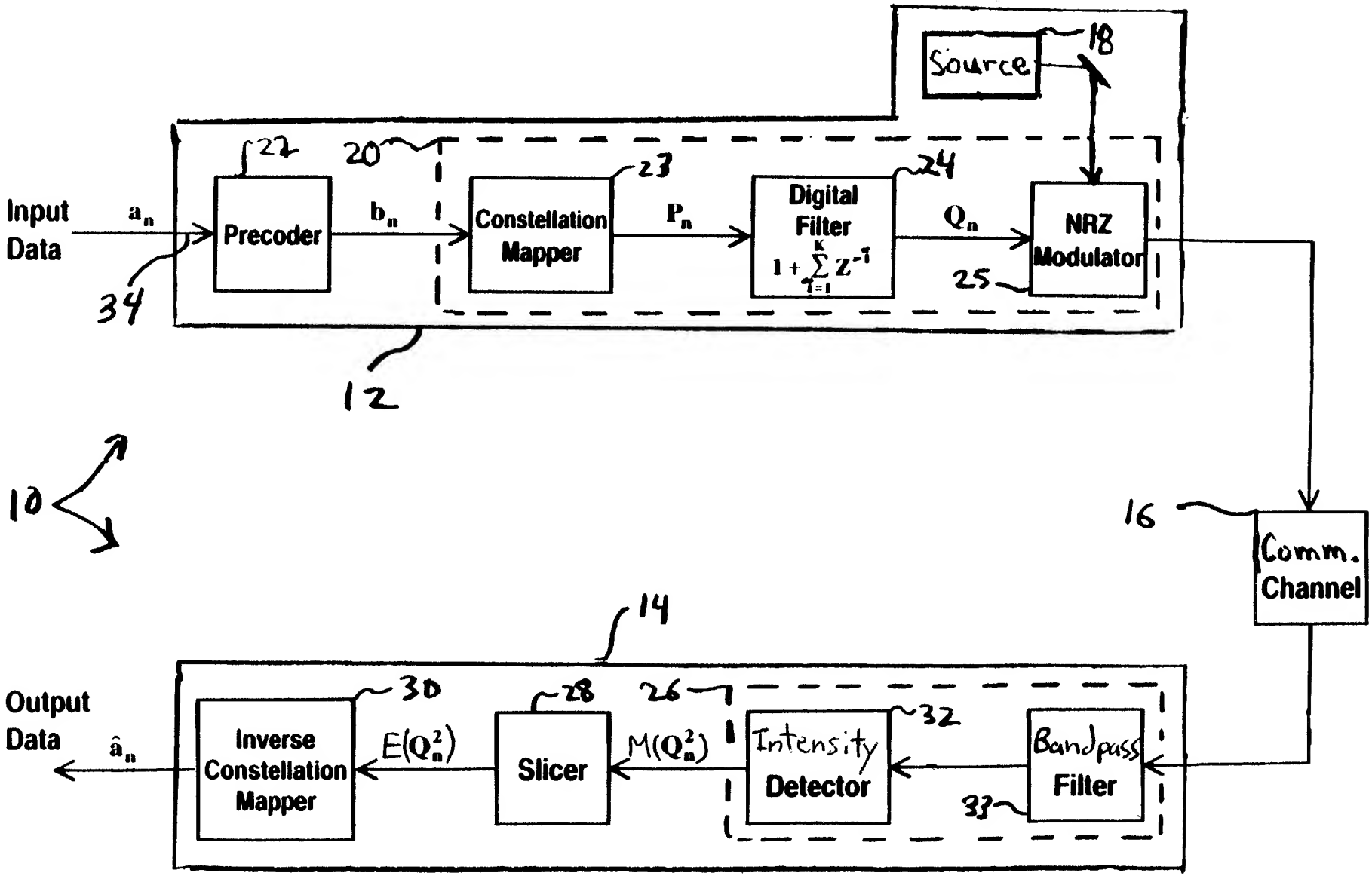
Source
18
27
20
23
24
Input Data
a_n
Precoder
b_n
Constellation Mapper
P_n
Digital Filter
$1+\sum_{i=1}^{K} z^{-i}$
Q_n
NRZ Modulator
25
34
12
10
16
Comm. Channel
14
Output Data
$\hat{a}_n$
30
28
26
32
Inverse Constellation Mapper
$E(Q_n^2)$
Slicer
$M(Q_n^2)$
Intensity Detector
Bandpass Filter
33

Figure 1

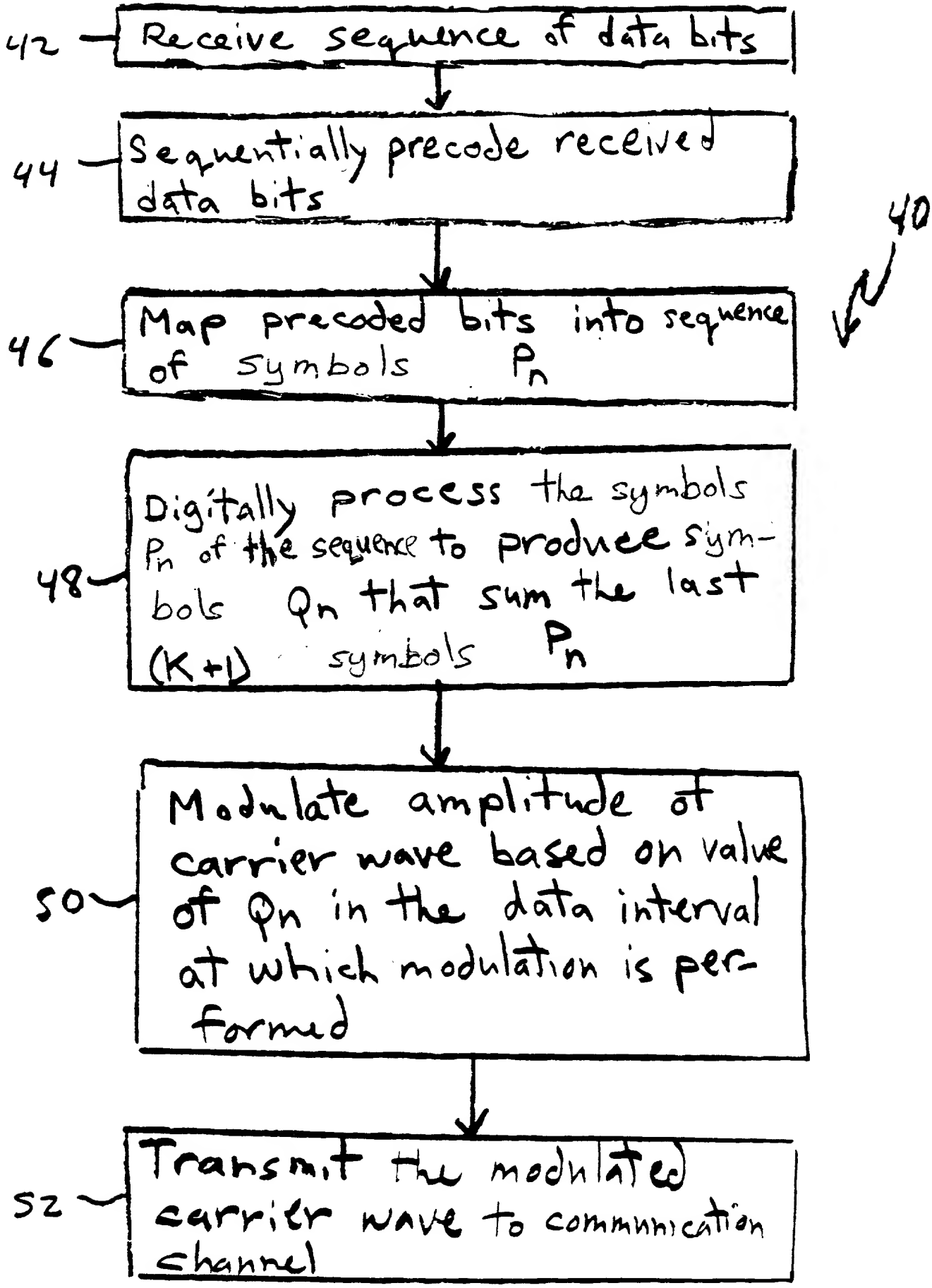
42
Receive sequence of data bits
44
Sequentially precode received data bits
40
46
Map precoded bits into sequence of symbols P_n
48
Digitally process the symbols P_n of the sequence to produce symbols Q_n that sum the last (K+1) symbols P_n
50
Modulate amplitude of carrier wave based on value of Q_n in the data interval at which modulation is performed
52
Transmit the modulated carrier wave to communication channel

FIGURE 2

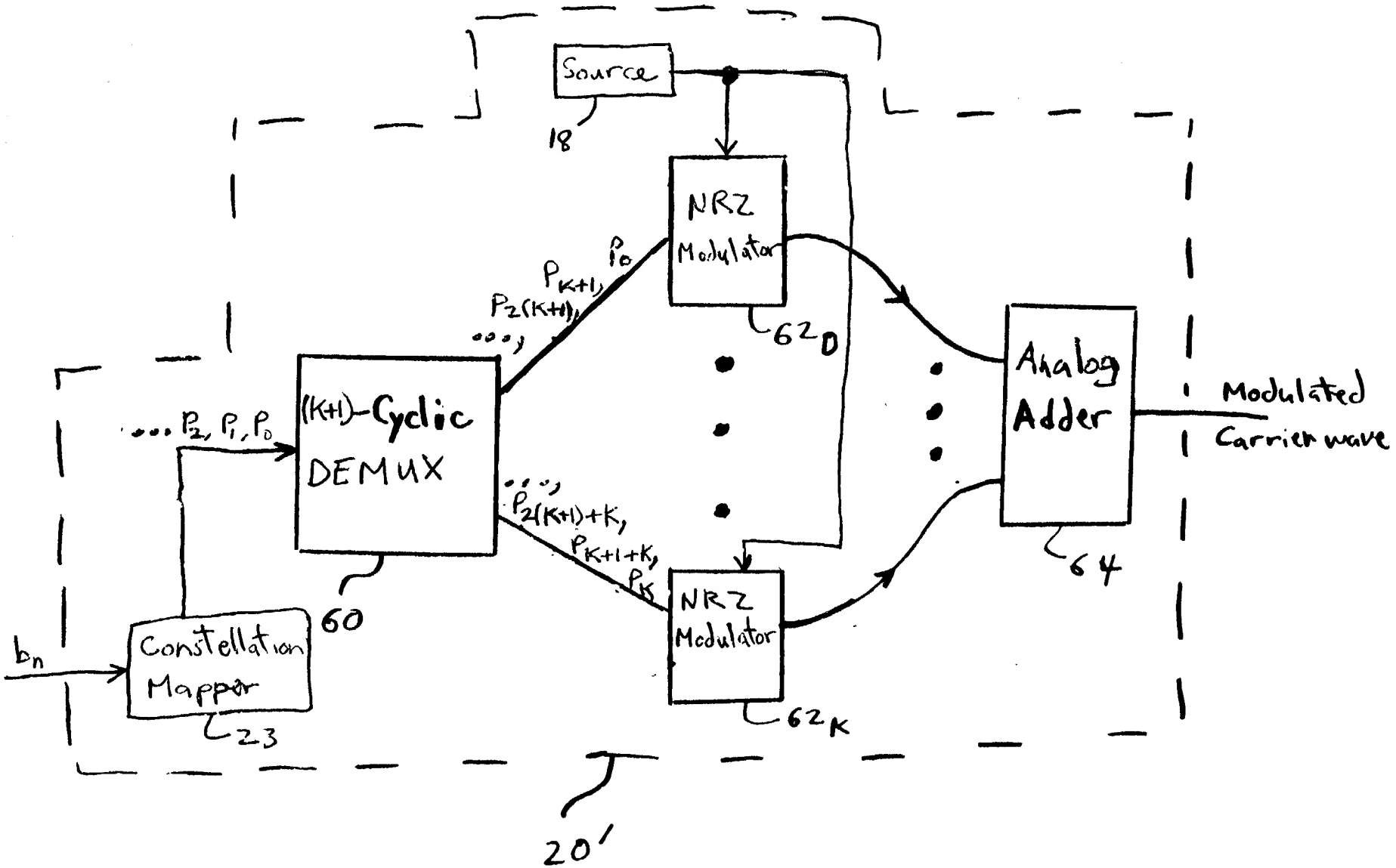
Source
18
NRZ Modulator
62₀
Analog Adder
64
Modulated Carrier wave
(K+1)-Cyclic DEMUX
60
Constellation Mapper
23
b_n
P_0
P_{K+1},
$P_{2(K+1)}$,
...,
... P_2, P_1, P_0
...,
$P_{2(K+1)+K}$,
P_{K+1+K},
P_K
NRZ Modulator
62_K
20'

FIG. 3

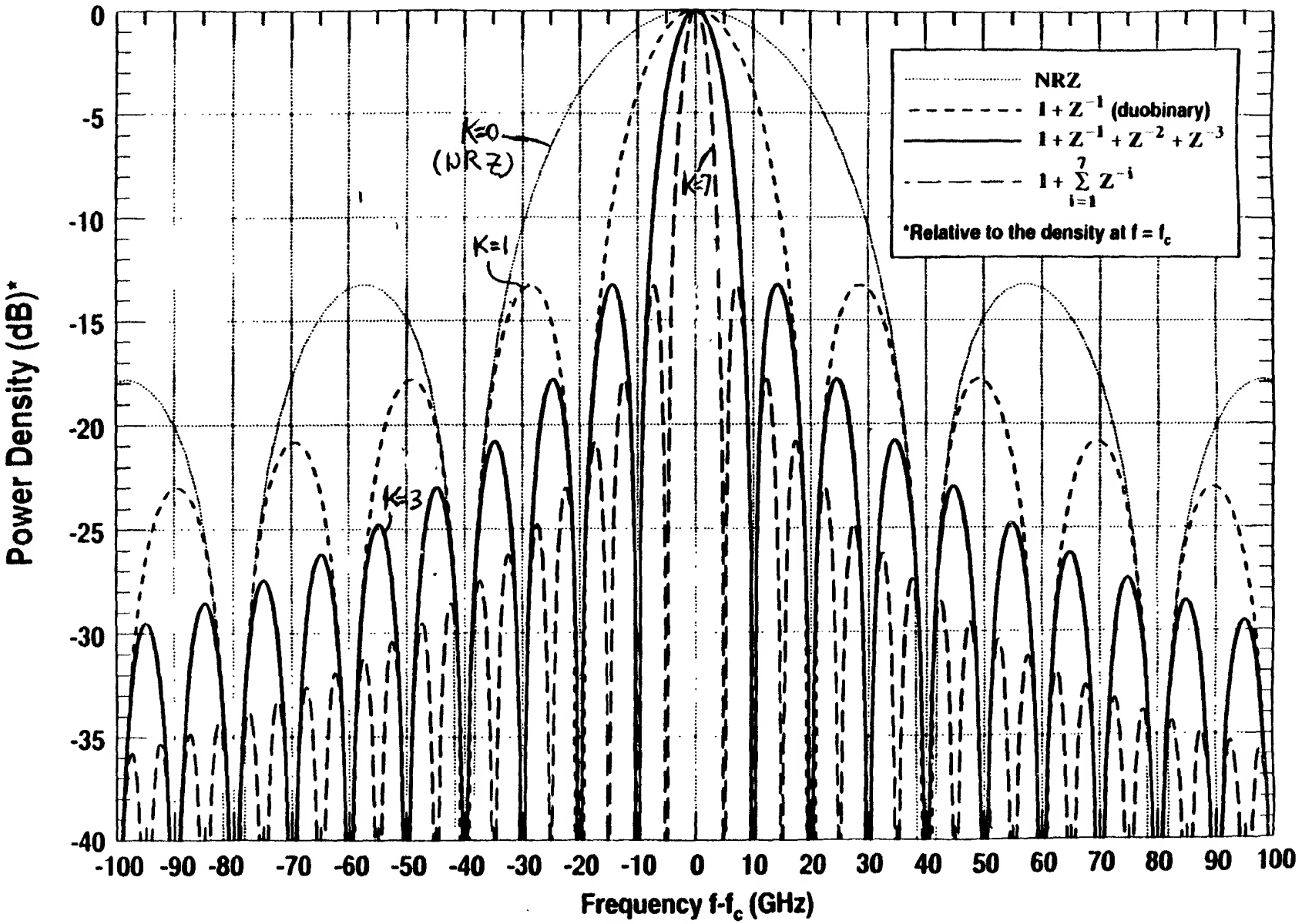
NRZ
1 + Z^-1 (duobinary)
1 + Z^-1 + Z^-2 + Z^-3
1 + Σ Z^-i (i=1 to 7)
*Relative to the density at f = fc
K=0 (NRZ)
K=1
K=3
K=7
Power Density (dB)*
Frequency f-fc (GHz)
0
-5
-10
-15
-20
-25
-30
-35
-40
-100 -90 -80 -70 -60 -50 -40 -30 -20 -10 0 10 20 30 40 50 60 70 80 90 100

Figure 4

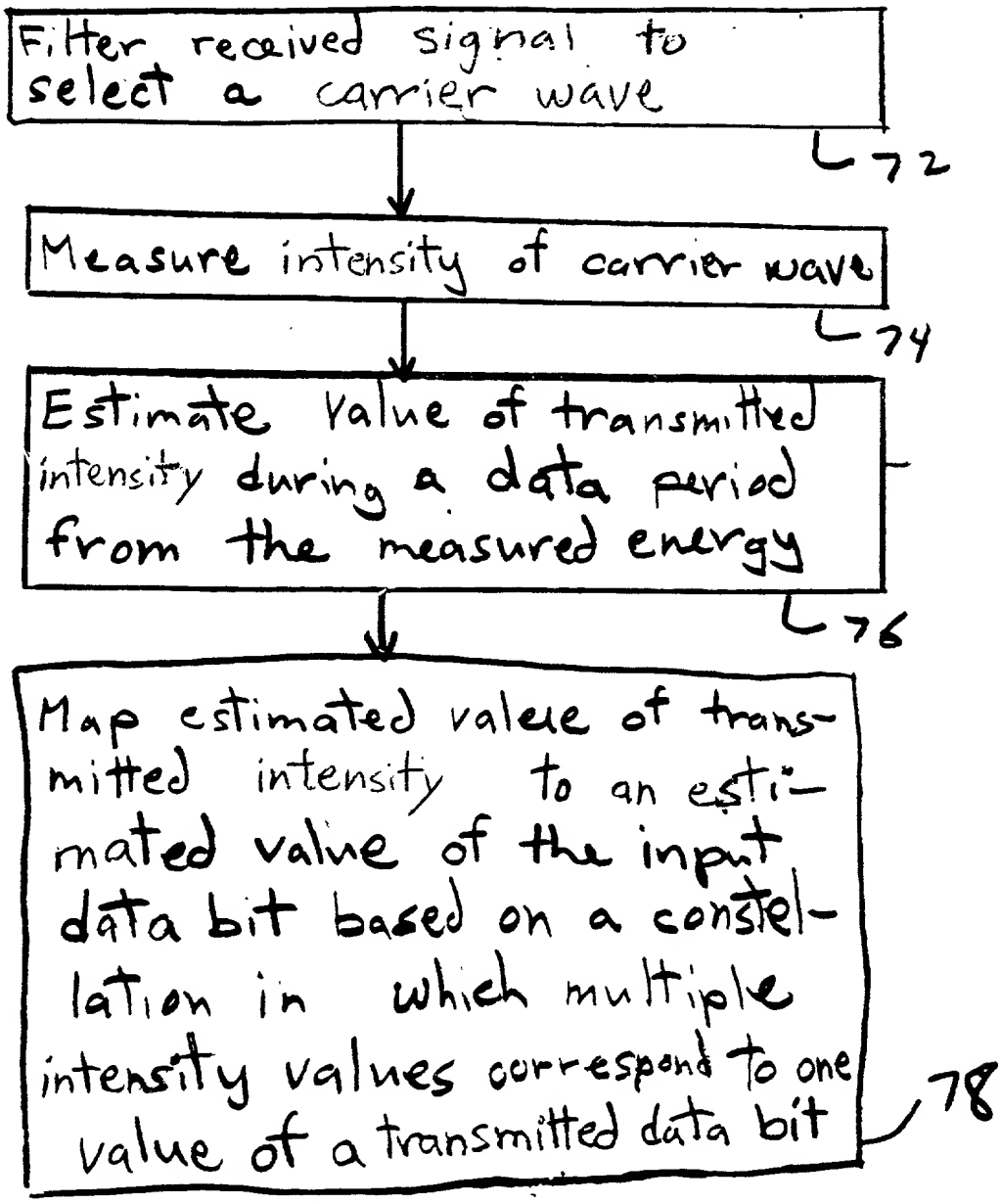
Filter received signal to select a carrier wave
72
Measure intensity of carrier wave
74
Estimate value of transmitted intensity during a data period from the measured energy
76
Map estimated value of transmitted intensity to an estimated value of the input data bit based on a constellation in which multiple intensity values correspond to one value of a transmitted data bit
78
70

Figure 5

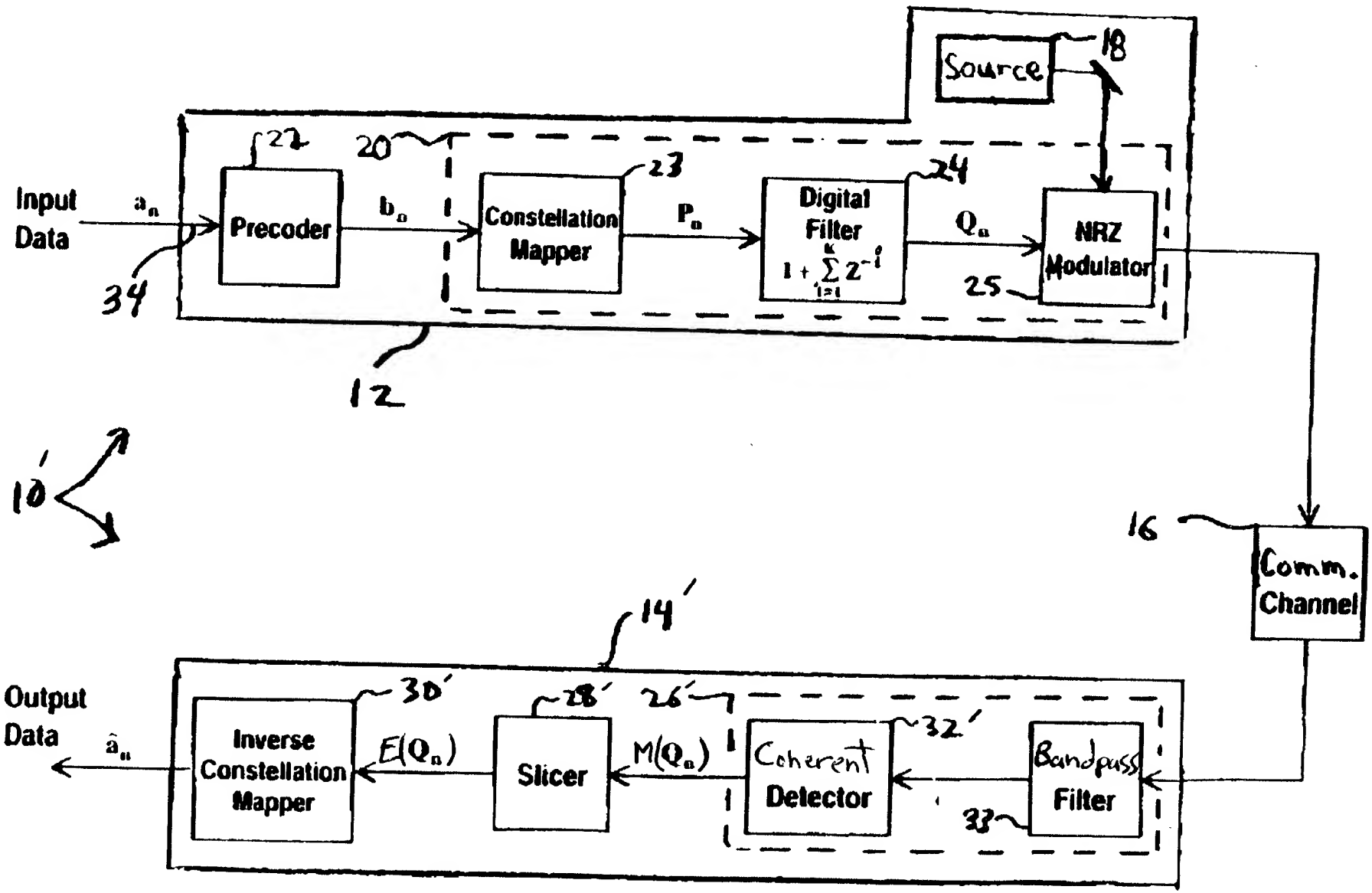
Source
18
22
20
23
24
Input Data
a_n
Precoder
b_n
Constellation Mapper
P_n
Digital Filter
$1+\sum_{i=1}^{K} 2^{-i}$
Q_n
NRZ Modulator
25
34
12
10'
16
Comm. Channel
14'
Output Data
$\hat{a}_n$
30'
28'
26'
32'
Inverse Constellation Mapper
$E(Q_n)$
Slicer
$M(Q_n)$
Coherent Detector
Bandpass Filter
33

Figure 6

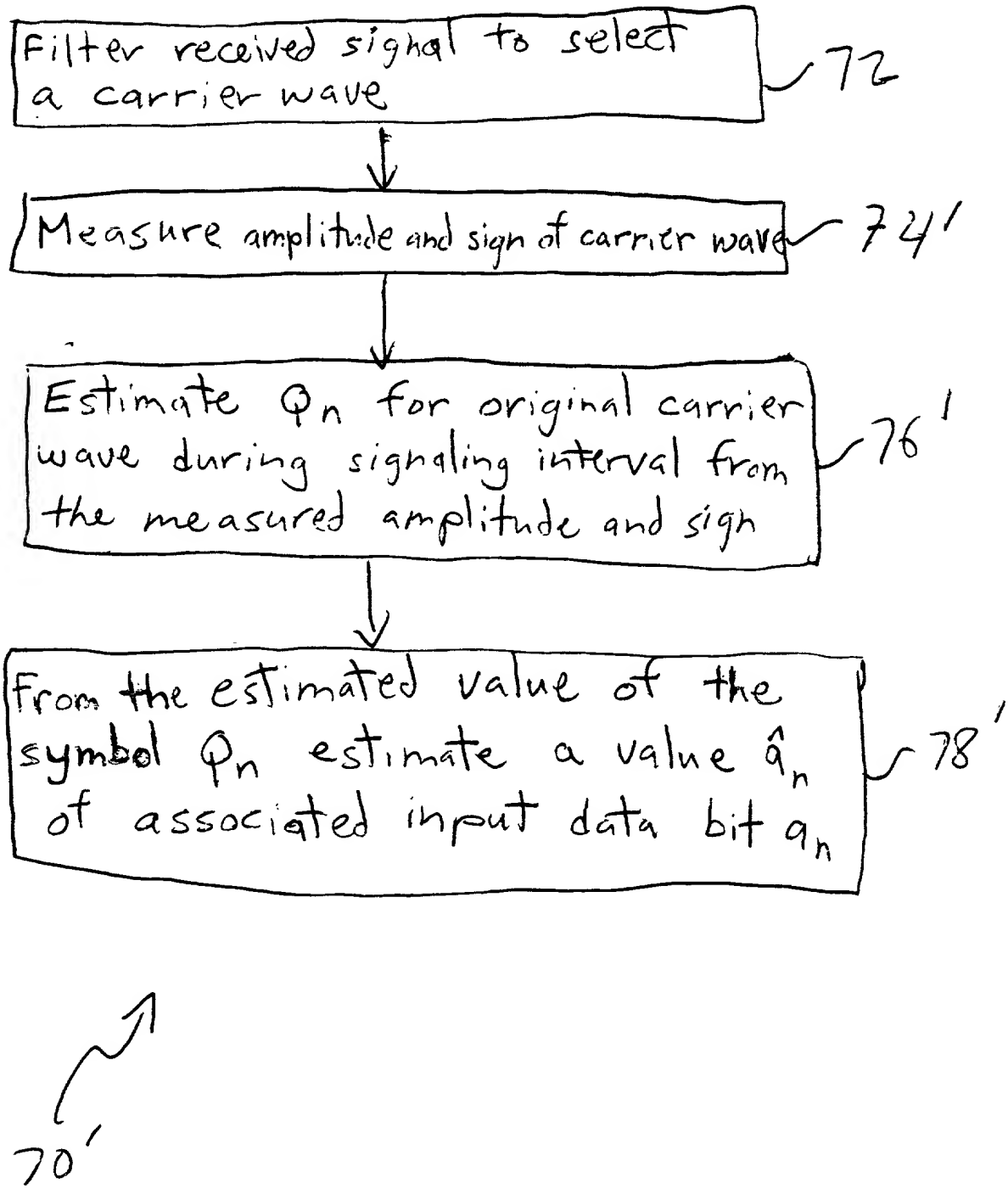
Filter received signal to select a carrier wave
72
Measure amplitude and sign of carrier wave
74'
Estimate φ_n for original carrier wave during signaling interval from the measured amplitude and sign
76'
From the estimated value of the symbol φ_n estimate a value $\hat{a}_n$ of associated input data bit a_n
78'
70'

FIG. 7

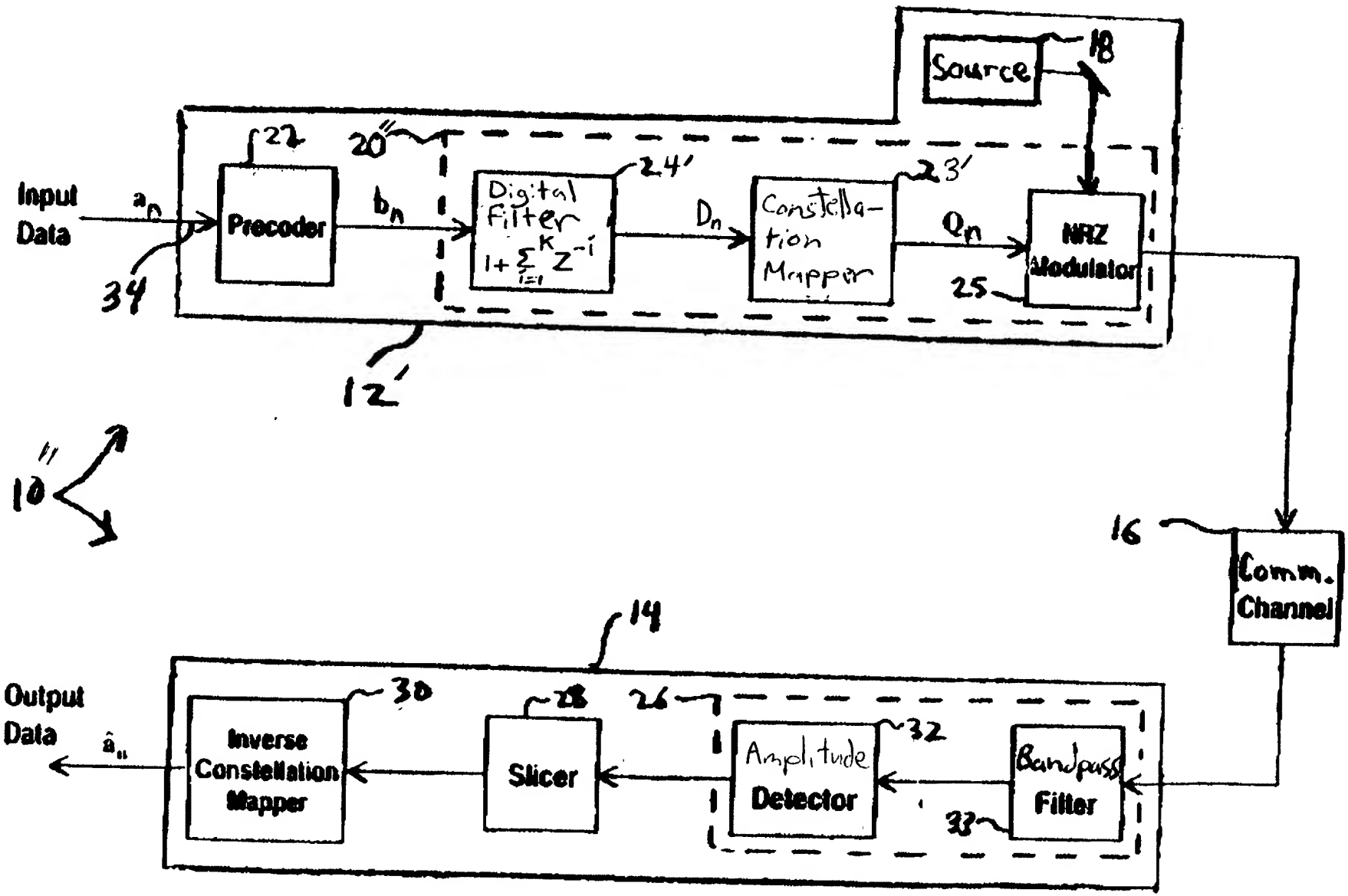
Source
18
22
20''
Input Data
a_n
Precoder
b_n
Digital Filter
$1+\sum_{i=1}^{K} Z^{-i}$
24'
D_n
Constella-tion Mapper
23'
Q_n
NRZ Modulator
25
34
12'
10''
16
Comm. Channel
14
Output Data
$\hat{a}_n$
30
Inverse Constellation Mapper
28
Slicer
26
Amplitude Detector
32
Bandpass Filter
33

Figure 8

Digital Filter	Normalized Signal Bandwidth*	Loss in Receiver Sensitivity (dB)*	Number of Transmitter Signal Amplitudes Q_n	Number of Receiver Signal Amplitudes Q_n^2
$1+Z^{-1}$ (duobinary)	$\frac{1}{2}$	0	3	2
$1+Z^{-1}+Z^{-2}+Z^{-3}$	$\frac{1}{4}$	3	5	3
$1+\sum_{i=1}^{5} Z^{-i}$	$\frac{1}{6}$	4.8	7	4
$1+\sum_{i=1}^{7} Z^{-i}$	$\frac{1}{8}$	6	9	5
⋮	⋮	⋮	⋮	⋮
$1+\sum_{i=1}^{15} Z^{-i}$	$\frac{1}{16}$	9	17	9

*Relative to a baseline on/off NRZ modulation.

FIG. 9